NOTES

1. Papers selected for inclusion in General Sessions will be available at the Conference in the following official languages of the United Nations: English, French, Russian and Spanish.

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RECONNAISSANCE MAPPING FOR DEVELOPING COUNTRIES

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Two sets of reconnaissance mapping techniques from airphotographs, related with the evaluation of natural resources of large areas insufficiently known, are described and discussed:

a) Topomorphic Maps:

The preparation of a suitable base map, on which to compile available information, plan new investigations, and coordinate final results, represents usually the first problem to be faced in exploration of natural resources in large, unmapped areas. Accepting the fact, that topographic contour maps meet the requirements for exploration and development the best, the use of such maps is, however, limited, by the slow production rate and high cost. On the other hand, the direct use of controlled, or semi-controlled photomosaics and photoplans, as field maps and as final base maps, has proved unsatisfactory mainly because of difficult interpretation (poor readability), impossibility to reduce disturbing parallax effects, costly reproduction. A frequently used, but hardly satisfactory, compromise is the combination of photomosaics and sketchy "Planimetric" maps, used separately for the various purposes of one project.

Turning our mind to the design of a type of map fitting to the case, we may consider the following principal facets:

1) Readability and facility of use as office and field maps - The base map is a many-purposes tool to be used by various technicians, of various attitudes and training, at various stages of the survey (geologists, geophysicists, engineers, soil specialists, helicopter pilots, drivers etc.) It must also help the readers of final reports to grasp the significant relationships between the land features and the geologic, ecologic and other features.

The past experience and modern studies converge in pointing to symbolized linedrawn maps rather than to the direct use of the airphotographs, mainly on account of readability and dimensional properties (correction of parallax).

These requirements, together with facility of reproduction, are met by conventional topo-maps and by planimetric maps. They are not met by photomosaics and photoplans.

2) All-over versatility and fitness to specific purpose - The two requirements mentioned are only apparently in contrast to each other. In effect, most modern topographic maps are good examples of an optimum balance, taking into account the fitness to the most frequent objectives, (engineering, transportation, military, agriculture, economic development). This result can only be achieved with symbolized representations allowing various degrees of emphasis on selected natural features. The planimetric maps of usual form meet very poorly the first of these requirements due to their very low content in morphologic information.

3) Speed of production - The production rate of the base maps, has a great influence on programming and carrying out complex field operation. In the majority of cases it is highly desirable to make availablethe field-maps to the planners and to the operators of surface surveys at the earliest stages. This requirement is usually met by photomosaics, by planimetric maps and not by restituted topo-maps.

4) Cost - Cost represents a very critical factor for many projects. The procedures for minimizing this factor lead often to very poor base maps of minimum versatility.

If it is true that the relative costs of reasonably controlled mosaics and sketchy planimetric maps versus complete contour maps is in the range of 1 to 30 or 1 to 50 for scales in the range 1:50.000 to 1:200.000, it is also evident that within such a large gap must lie some intermediate solution fitting to a number of situations.

From the previous analysis it appears that reasonable compromises can be found in the range of symbolized representations of the land forms, drawing as much information as possible from the airphotos, with a reasonable minimum of metric control.

The "Topomorphic" maps here submitted (fig. 1 to 4) exploit the current techniques for controlled mosaics and reconnaissance mapping. Their basic characteristics are:

- Acceptable horizontal control of a reconnaissance nature (Astro fixes, mechanical radial triangulation, rectification, partial parallax corrections by 3rd order instruments if required and possible).
- Qualitative (or "artistic") representation of land forms, helped by estimates and approximate measurements on the stereomodel. The symbolized representation of natural and human features is first designed as to enable the traveller to recognize its ground location as easily and accurately as possible.
- Emphasis on structural, lithologic, hydrologic, agricultural or other features is given in accordance with the projects' purposes. This is obtained by keeping the specially trained interpreter-cartographers well informed on the subject. The degree of selected emphasis is generally moderate, as to leave intact the versatility of the map.
- The production rate of such maps is obviously controlled first by the securing of the basic geodetic control (astro fixes or other) and by the availability of highly skilled cartographers, with a good basic naturalistic knowledge. The man/month production can be made to range in the hundreds of sq.Km. for 1:50.000 scale and in the thousands of sq.Km.for 1:100.000 scale maps.
- The cost of construction, excluding the airphotography and the ground geodetic control, range in the fractions of dollar for scales 100.000 or smaller. Reproduction possibilities are of the easiest kind.

b) Fractures and linears:

It is only in the few past years that the investigation of fractures and joint patterns has been developed to a point where application to geologic problems of an economic nature can be considered. Thanks to the work of geologists and engineers (1). We can list the following applications: mining exploration and production development, civil engineering in roads, dams and underground reservoir construction; oil exploration as complementary photogeologic tool in blanketed areas, as help in structural interpretation of geophysical surveys, and in locating fracture belts affecting secondary permeability; geothermal energy exploration (2), as help in locating important carrier-fractures, defining structure and buried intrusions.

As it always happens to new branches of research, the techniques are under rapid evolution, in the attempt to define the fields of maximum efficiency of various possible approaches.

The photogeological approach to fracture studies has opened the door to regional investigation on a large scale. The consequent sudden flow of data has forced the processing techniques into statistical methods.

The following outline of mapping and processing techniques has been developed and tested for the investigation of large areas rather thar for the highly detailed study of a local situation.

i) Mapping the basic data

It is important that a classification of the linears, according to morphologic and genetic criteria appears in the first or "total" map. This classification will allow further processing to take into account relative weights or different mechanical meanings. Well defined faults and joints belts should be kept separated from other linears of a less defined nature. Further subdivision of the "morphologic" linears into "tonal line", "tonal boundary", "microdetails alignment" are examples of convenient classifications, which can be easily symbolized (fig.5).

The procedures for the transfer of photo annotations on a base-map do not differ from the usual photogeological procedures, but should be selected among these allowing standardized operation of high efficiency. Projection printing on 9 reference points per photograph meets, in most cases of flat areas, the requirements of accuracy and speed for scales 1/50.000 down. Mountainous areas will require some amount of parallax correction.

ii) Mapping the numerical results of statistical processing

The resort to statistical methods proceeds from the need of an objective lead admist a very large amount of rather uniform data. The quantities measured are lengths and azimuths. It is common practice to compute the total length of linears, within azimuth classes of a given amplitude (10° or 20°), and to express them in percentages of the total length within the area. The resulting figures can be plotted as orthogonal stereograms or as polar diagrams. The advantage of the latter representation is to maintain the azimuths for visual comparison with the basic data and with information of other kind (stratimetry, geophysics). Fig.6 is an example of such representation in which also the geographic location is preserved, by centering the polar diagram at the center of the area unit (0°10' Lat.-Long. rectangles). The same figure is also an example of separated computation of data, showing the well defined fractures and joints in the upper half of the diagram, and the "morphologic linears" in the lower half.

A similar presentation can be adapted to show the linears' distribution within area units other than geographic; as for example tectonic units, or outcrop areas of given stratigraphic units.

iii) Mapping selected information

As mentioned before, one very important condition to be considered in plotting processed information is to favor, in the highest possible degree, the comparison with information from other sources. One useful procedure consists of extracting from the total map, some data, according to statistical distribution peaks (fig.7). Fractures' trends, selected by such objective procedure as outlined, may be further elaborated on the basis of absolute density.

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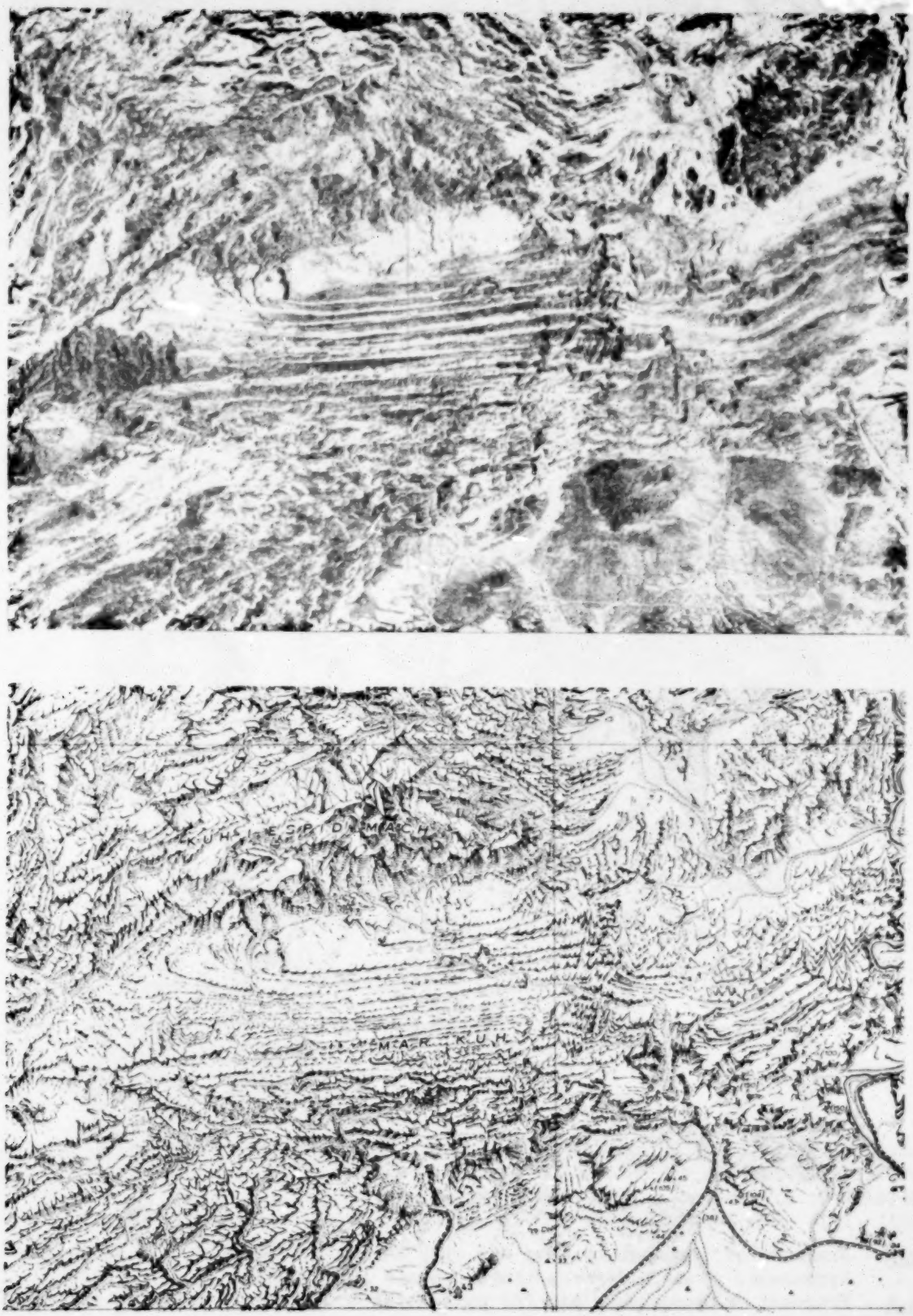

Fig.1-2 - Fragment of photomosaic and topomorphic map, scale 1:100,000 (photoreduction from originals at the scale 1:50.000) - Iran. Base map for oil exploration.

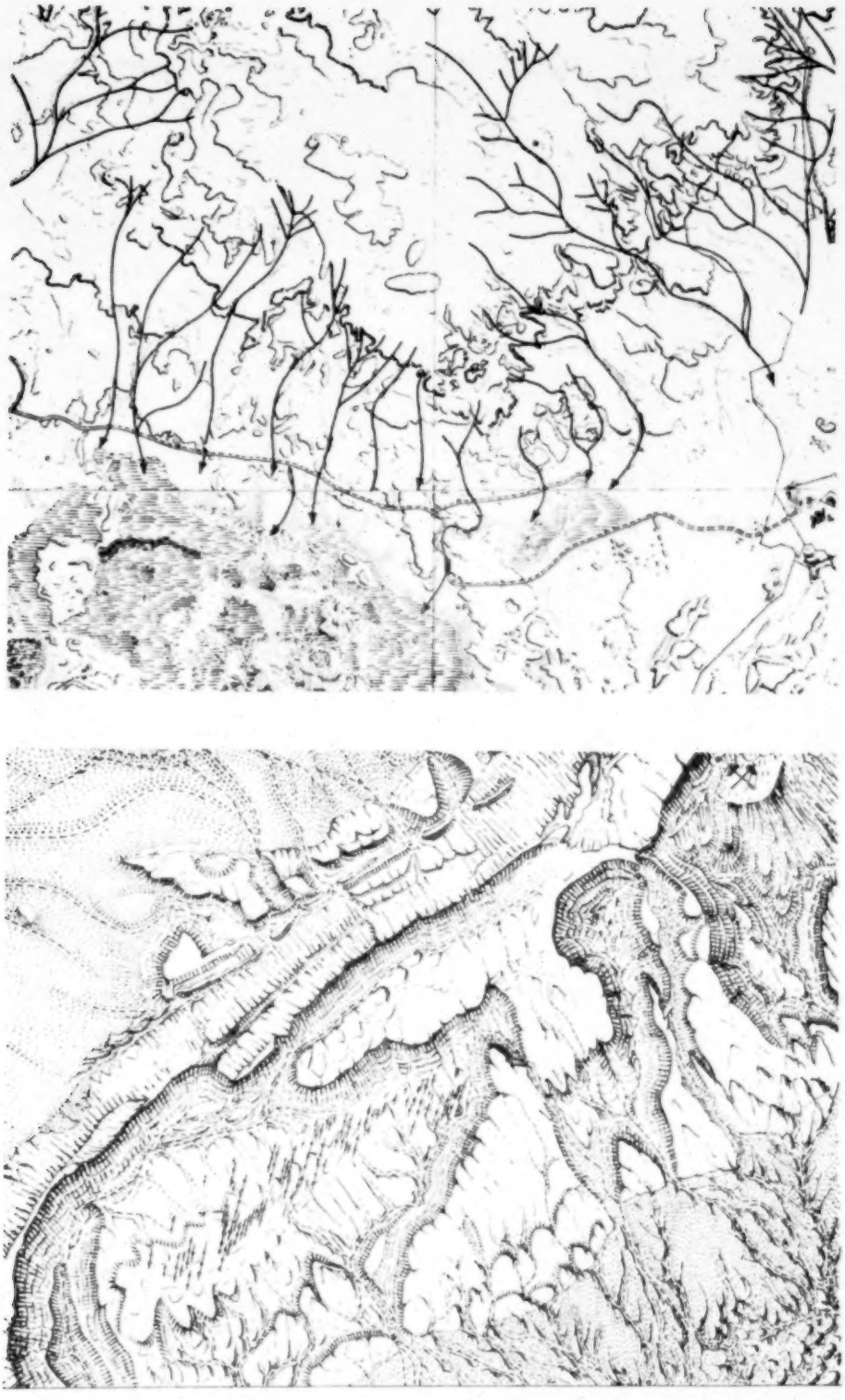

Fig.3 - Fragment of topomorphic base map with emphasized drainage for structural and hydrologic study. Eastern Libya. Scale 1:100.000.

Fig.4 - Fragment of topomorphic map for base metal prospecting. Scale of original 1:25.000. - slightly reduced.

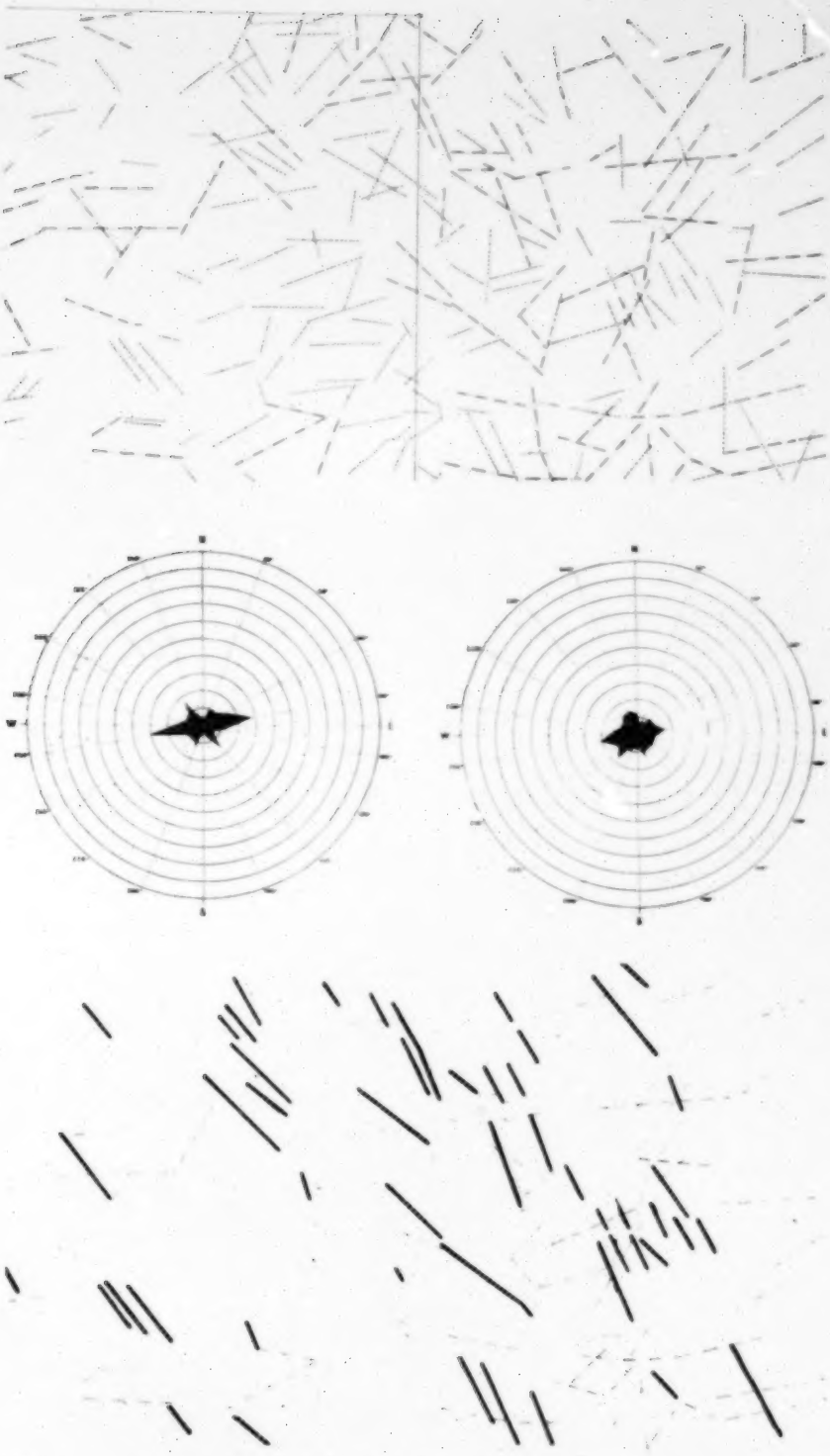

Fig.5, 6, 7,- Three maps from a study of airphoto linears: 5) Total field of linears showing symbolized classification. 6) Map of distribution of linears by 20° azimuth classes. "Recognized fractures" in upper half of diagram, "morphologic linears in lower half". Area units of 0°10' Lat.-Long. 7) Map of selected trend.

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